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The Rainfall of 1921.

THE completion of the rainfall records for 1921 has been awaited with unusual interest, less because the end of the year puts any natural period to the dry spell which has been so prominent a feature in the south and east of the country, than because it affords a convenient opportunity of carrying out a comparison between the conditions during the year and those during previous years.

It is not, of course, possible within a few days of the end of December to give any comprehensive summary of the year's records, but by making a selection from the 3,000 returns so far received we are able to give a preliminary idea of the distribution in relation to the average.

The year has undoubtedly been one of very unusual shortage of rainfall, but the area affected in an extreme degree was not very large. In the western half of Scotland, largely owing to the heavy rains of January, March, and December the total was above the average at all stations, and over a large part of the Western Highlands there was an excess of more than 10 per cent. reaching 20 per cent. in places. A small area in the northern Pennines and isolated spots in Ireland also had more than their average rainfall, but with these exceptions the year's fall was apparently everywhere defective. The deficiency increased in a marked manner towards the east and south. In the north-east it culminated in a rainfall of 40 per cent. below the average around Aberdeen, and in the south of Ireland in a deficiency of more than 30 per cent. to the east

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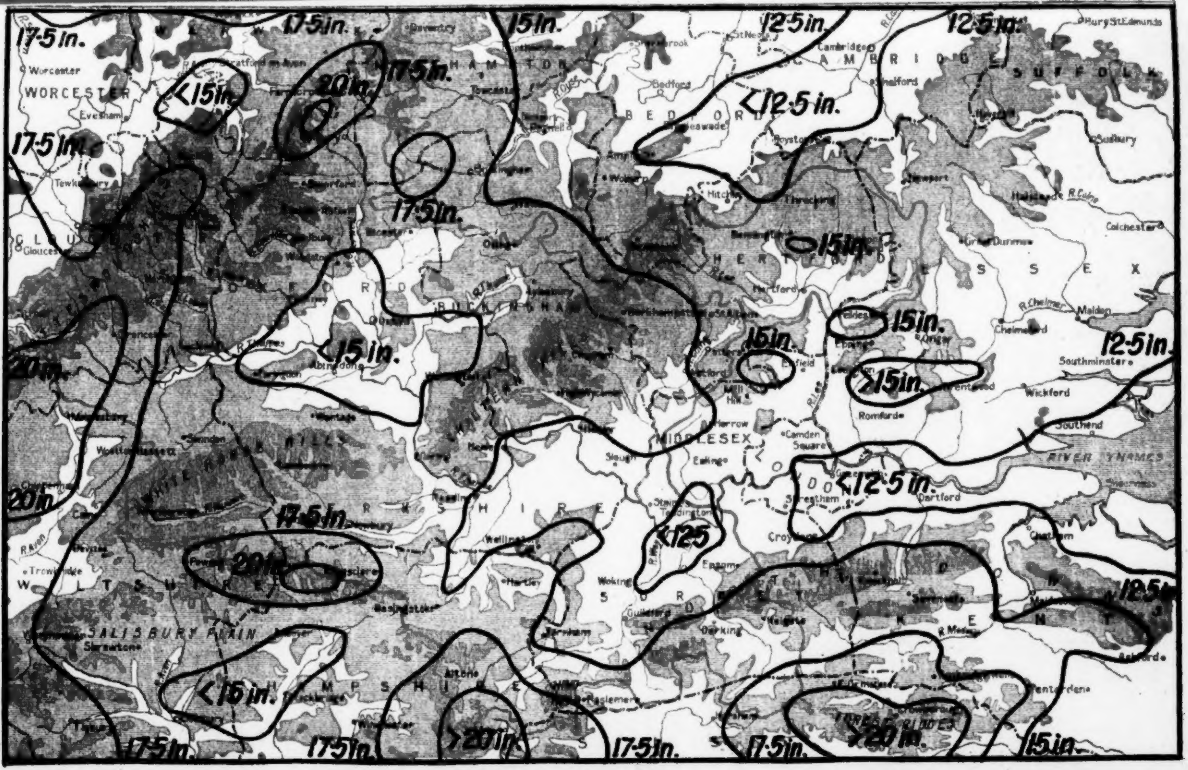
of Cork, but these were local dry centres. In England, and part of South Wales the whole country south-east of an irregular line from the Bristol Channel to Yorkshire experienced a deficiency of more than 30 per cent. and nearly all the district beyond a line from Plymouth to Yarmouth a deficiency of more than 40 per cent., whilst the east of Kent exhibited the quite unprecedented phenomenon of a rainfall less than half its average.

The conditions in the south-east of England so far transcend any records within the period over which trustworthy observations extend that it will be necessary to revise the empirical law hitherto found to hold good for this country as well as for most parts of the world with an annual average rainfall exceeding about 20 inches, namely, that the fall of the driest year will not fall appreciably below 60 per cent. of the normal. The driest years hitherto recorded in the British Isles were probably 1854, 1864, 1870, and 1887. In all these years considerable areas had less than 70 per cent. of the average and in 1887 nearly the whole of England and Wales, as well as more than half the area of Scotland and Ireland, had less than 80 per cent., but so far as we are able to ascertain the deficiency nowhere reached 40, much less 50 per cent. The general percentage of the average rainfall in these four dry years is given in the following table for comparison with 1921. In the case of 1854 the data were insufficient to establish values for Scotland and Ireland, but these districts were probably wet.

—	1854.	1864.	1870.	1887.	1921.
England and Wales - -	77	78	82	74	71
Scotland - - - - -	..	94	80	80	99
Ireland - - - - -	..	86	95	77	88
British Isles - - - -	..	85	84	77	82

The area covered by the map of the Thames Valley, published in each number of this magazine, includes so large a part of the district with an unprecedentedly low rainfall that we gladly acquiesce in the suggestion of a reader to publish a supplementary map showing the total fall for the year. This map shows that the highest rainfall in the Thames Valley was barely 20 inches (500 mm.), and this only in one or two spots, and that over nearly the whole valley it was less than 17·5 inches (450 mm.). Along a broad belt on both sides of the main river below Lechlade, interrupted where the high land approaches closely between Goring and Reading, there

THAMES VALLEY RAINFALL — YEAR, 1921.



Watershed of River Thames above Teddington and River Lee above Feildes Weir.

Isohyetals.

ALTITUDE SCALE: Below 250 feet | 250 to 500 feet | 500 to 1000 feet | Above 1000 feet

SCALE OF MILES: 0 5 10 15 20

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was less than 15 inches (380 mm.) during the year, and in the north-east of the area included the fall was everywhere less than this amount. The most remarkable totals were observed in the Thames Estuary and the southern Fen District, where considerable areas had less than 12 inches. These were undoubtedly the driest places in England during this remarkable year.

The following table gives the general rainfall of each

Monthly General Rainfall as Percentage of Average.

1921.	England and Wales.	Scotland.	Ireland.	British Isles.
January	146	168	119	145
February	15	39	51	34
March	101	170	129	133
April	59	61	46	56
May	79	108	90	91
June	17	40	24	26
July	40	105	130	87
August	115	106	108	110
September	64	81	53	64
October	51	105	92	80
November	75	55	106	75
December	83	133	80	101

month in the great divisions of the British Isles, as a percentage of the average of the 35 years 1881–1915. It will be observed that January, March and August were the only months with appreciable general excess, though July was wet in Ireland and December in Scotland. The most noteworthy months of the year were February and June for the British Isles as a whole and more locally July and October. February had less than a quarter of its average practically everywhere in England and Wales as well as in the east of Scotland and part of the centre of Ireland. It was driest in South Wales where less than 5 per cent. of the average fell. The only Februaries, for which comparable data exist, which appear to have been drier were in 1891 and 1895, but the difference was not great. June was beyond doubt the driest of which any record exists, having less than a quarter of the average practically everywhere except in the north of Scotland and less than 5 per cent. of the average along the whole of the south coasts of England, Wales and Ireland with no rain at all in parts of Sussex and of Pembrokeshire. The drought of June was continued throughout July in the south-east of England where that month was not much less dry than its

predecessor, but to the north-west considerably more rain fell, and in Ireland and the western Highlands the month definitely terminated any tendency to rain shortage. The dryness of October was also local, a deficiency of 50 per cent. being confined to the south of England and Wales and parts of the East Coast. In the extreme south less than 25 per cent. of the average fell, and in places the month was the driest October known to have occurred. The remarkable features of the rainfall of 1921 are more vividly brought out by study of groups of months. It will be observed that in some part of the south-east of England every month of the year was dry and several of them very dry indeed. The cumulative effect was probably most pronounced in the period February to July inclusive. During these six months the whole of the south-east of England and Wales experienced less than half the average rainfall and a large tract extending from Monmouthshire to Lincolnshire, as well as other local areas, less than two-fifths of the average. In the notably dry year 1887 the six months, February to July, had less than half the average rainfall in the south-east of Ireland, the south-west of England, and part of Yorkshire, with less than 40 per cent. in Cornwall and South Devon; and in the great winter drought of 1879–80 less than half the average fell over the south coast of England during a period as long as eight months, but these are probably the only comparable periods. Equally remarkable was the period February to October 1921: during these nine months less than half the average rainfall fell to the south-east of a line drawn roughly from Plymouth to Cromer and less than 40 per cent. over a narrow strip in the south of Dorset, Hampshire, Sussex, and Kent. The driest nine months in 1887, also from February to October, fell below 50 per cent. only in a small patch in the south-east of Ireland, and for the most part had more than 60 per cent. of the average fall.

It is as yet too early to speak definitely as to the effects of a year of such remarkable deficiency. There is no question that great want of water has been experienced in rural districts where local supplies are depended upon, and although the greater municipal supplies have mostly held out well there has been, in many cases, keen anxiety as to their adequacy. Most of the water supplies of the south-east of England are drawn from underground sources, and it may well be that well-supplies are being used up in a manner analogous to living on capital. It is known that the underground water in the chalk formations depends intimately upon the rainfall for its maintenance, and in particular the

winter rains percolate freely into the fissures of chalk and compensate for the draft made during the summer. It is an ominous fact that percolation records made during the year in the south of England show that no water has reached the chalk since May, and that the quantity since February 1st has been not more than the equivalent of 1·75 inch of rain. Unless, therefore, an unusually rainy period intervenes between this and the early summer the outlook for the summer of 1922 from the point of view of water supply is not very promising.

OFFICIAL NOTICES.

Meteorological Stations.

Falmouth Observatory.—Meteorological observations have been carried on at Falmouth since the founding of the Royal Cornwall Polytechnic Society in 1833. In 1867 the Meteorological Committee of the Royal Society recognised Falmouth as one of the seven observatories of their network and provided the necessary equipment. The first site of the observatory was in the town at 200 feet above sea-level. From 1885 a house with less urban surroundings (167 feet above M.S.L.) has been used. The situation is charming as may be gathered from the illustration in the official list of stations (001 J, 1919). Since 1902 there has been a Dines anemometer at Pendennis Castle on an exposed headland a mile from the observatory, and the comparison of wind-records from the two stations has been of great interest.

Mr. J. Lovell Squire was the first superintendent of the observatory; he was succeeded in 1882 by Mr. Edward Kitto, who held the position until 1913. On Mr. Kitto's retirement it was arranged that the society should lend the observatory premises to the Meteorological Committee, who should be responsible for the staff, equipment, and work. Up to this time the preparation of hourly values from the autographic records had been the principal part of the meteorological work, but under the new plan the observatory became a telegraphic reporting station. The photographic barograph and thermograph were dismantled and magnetic observations ceased, it being intended to develop the station as a centre for upper-air observations.

At the end of the year 1921 the Meteorological Office gave up its tenancy of the observatory, and observations for the daily

weather service are now being made at the coastguard station at Pendennis Castle. The Royal Cornwall Polytechnic Society propose, with the assistance of the Town Council, to carry on climatological observations at the observatory, for the present year at least, and these will be published in the *Daily Weather Report* under the heading "Health Resorts." Mr. J. B. Phillips, who has been acting as meteorologist in charge of the station for some time, has been so good as to volunteer to take charge of this work.

Huddersfield.—The Meteorological Station at Huddersfield is to be transferred from Edgerton Cemetery to Ravensknowle, where it will be in close connection with the Tolson Memorial Museum. The Edgerton station was founded in 1876 by Mr. James Firth on his appointment as Registrar of the Cemetery. He had, previously to this, taken much interest in the weather and had supplied summaries to the local press. In 1895, his son, Mr. Joe Firth, succeeded him and the station was reorganised to meet the needs of the Meteorological Office. Mr. Firth has now retired after twenty-seven years' service for meteorology and his place as observer will be taken by Mr. C. Mosley, Assistant Curator of the Museum. The Tolson Memorial Museum is being designed to show the relation of human activity in the West Riding to the natural environment and the local climatology is therefore recognised as of fundamental importance.

Sheepstor.—The Rev. H. H. Breton is leaving Sheepstor, Devon, this month for a new living at Alfriston, near Eastbourne, and the meteorological station which he has maintained since 1907 will therefore lapse.

Torquay.—Mr. G. E. Body has succeeded the late Mr. P. C. Steventon as Borough Meteorologist to Torquay.

A list of the Distributive Stations of the Meteorological Office and their Auxiliary Reporting Stations as at present established is given below.

The Station at Howden and the Auxiliary Station at Goswick were closed on December 22nd, 1921, and November 30th, respectively, and the Station at Manchester was transferred to Shotwick on October 24th, 1921.

This list supersedes that given in the *Meteorological Magazine,* April 1920, p. 41.

The various types of stations are indicated by the letters in the first column.

Type	County.	Station.	Lat.	Long.	Height in feet above M.S.L.	Officer in Charge.
			N. ° ′	° ′		
R	Dublin	Baldonnell	53 16	6 23 W	280	A. Walters.
R	Fifeshire	Leuchars	56 23	2 52 W	40	W. Gillon.
C	Renfrewshire	Renfrew	55 52	4 24 W	48	J. J. Somerville.
U	Yorkshire	Flamborough Head.	54 7	0 5 W	150	Coastguard.
A	Anglesey	Holyhead	53 18	4 39 W	15	S. T. A. Mirrlees.
R	Cheshire	Shotwick	53 13	3 0 W	16	H. F. Jackson.
RI	Lincolnshire	Cranwell	53 2	0 31 W	236	W. H. Pick.
R	Devonshire	Cattewater	50 22	4 8 W	58	G. H. L. Douglas-Lane.
RI	Hampshire	Andover	51 13	1 31 W	295	C. D. Stewart.
RI	Hampshire	Calshot	50 49	1 17 W	10	H. W. L. Absalom.
RR	Hampshire	South Farnborough.	51 17	0 45 W	234	R. M. Stanhope.
C	Norfolk	Pulham	52 24	1 14 E	122	G. Harris.
R	Suffolk	Felixstowe	51 56	1 19 E	21	D. F. Bowering.
C	Surrey	Croydon	51 21	0 7 W	244	G. R. Hay.
U	Kent	Biggin Hill	51 19	0 3 E	610	T. H. Applegate.
RR	Kent	Isle of Grain	51 27	0 43 E	20	H. St. S. Dyke-Marsh.
C	Kent	Lympne	51 5	1 1 E	350	R. S. Read.
U	Kent	Hythe	51 3	1 5 E	5	Coastguard.
U	Sussex	Beachy Head	50 44	0 15 E	525	Coastguard.

C.—Civil Aerodrome or Civil Airship Station.
R.—Royal Air Force Station.
RI.—Royal Air Force Station (Regular Lectures and Instruction given in Meteorology.)
RR.—Royal Air Force Station (Associated with Research or Design.)
A.—Experimental Anemometrical Station.
U.—Auxiliary Observing Station.

Official Publications.

Geophysical Memoirs, No. 18. *Observations on Radiation from the Sky and an Attempt to Determine the Atmospheric Constant of Radiation.* By W. H. Dines, F.R.S. Price 1s. 3*d.* net.

In this Memoir Mr. W. H. Dines gives some of the results of observations made with the apparatus described in the *Meteorological Magazine* for October 1920, and with the earlier instruments which served the same purpose. The memoir will serve to explain the significance of the tables which have been appearing in the Magazine during the last year, one of which will be found on p. 366 of this issue. Thus under Zone I. in Table II. of the memoir we have the monthly values for 1920 of what is here called π I, a measure of the atmospheric radiation from the zenith on cloudless days. We see that for July 1920, π I only

reached 543 cal/cm²/day. Whereas with the hotter air of July 1921 the value (*Meteorological Magazine*, p. 262) was 647 cal/cm²/day. At the end of the memoir the method of computing J, the total radiation from the sky, is given and the result that the net radiation from the ground on clear days in 1920 had a mean value rather over 200 cal/cm²/day, is stated. In the notation of this Magazine this estimate may be written $X - J = 200$ in 1912 whereas for 1921 the corresponding result is $X - J = 708 - 538 = 170$; the latter figure is perhaps the more reliable as the method of averaging is more thorough.

It appears from the memoir that as contrasted with diffuse solar radiation the radiation received from the atmosphere itself comes almost exclusively from the lower layers. Using η to represent the ratio of the radiation emitted by a layer of air equivalent to one-tenth of the atmosphere (*i.e.*, with gravitance 100 mb.) to that of a black body at the same temperature Mr. Dines finds his data are concordant with the assumptions $\eta = \cdot 5$ for two-thirds of the heat energy and $\eta = \cdot 05$ for the remaining third. It is curious that although the greater part of the radiation is generally attributed to the presence of water vapour the relative humidity at the time does not make much appreciable difference in the radiation; it is the temperature that is all important.* No doubt the reason is that even when the air is at its driest there is enough moisture present to supply the radiation of the characteristic type; if there is not as much moisture as usual in the lowest thousand feet then that layer will supply less than its usual amount, but it will also be less effective in cutting off radiation from higher layers.

Discussions at the Meteorological Office.

Dec. 12th, 1921. *Atmospheric Stirring Measured by Precipitation, by L. F. Richardson.* (Proc. Roy. Soc., Vol. 96A, pp. 9–18). Opener.—Mr. N. K. Johnson.

G. I. Taylor in his paper† on "Eddy-motion in the atmosphere" made a successful attempt to deal with the phenomena of atmospheric turbulence.

On certain assumptions as to the general uniformity of the eddy-motion Taylor showed that heat and also momentum would be conveyed through the atmosphere in much the same way as heat is conducted through a solid. The equations at which Taylor arrived were of the same form as those used by earlier authors who had not considered the mechanism in such detail.

In the paper under consideration Richardson reverts to the

* *See* Q.J.R. Met. Soc., Vol. XLVII., 1921, p. 260.

† *Phil. Trans.*, A. 215, p. 1, 1914.

more general method—he is concerned with the power of eddies to convey heat or moisture or momentum from one horizontal layer to another rather than with the size and constitution of the eddies.

The type of equation which is adopted as most satisfactory for expressing results in comparable form is :—

$$\frac{\partial \chi}{\partial t} = \frac{\partial}{\partial p}\left(\xi \frac{\partial \chi}{\partial p}\right)$$

where χ represents any measurable "entity" capable of transfer according to the prescribed rules, p is the pressure at the level under consideration, and ξ is the measure of turbulence.

It is the object of the paper to evaluate ξ by the consideration of the relation between the ascent of water in the form of vapour and its descent as rain or snow. The processes which take the water upwards may all be pooled together as turbulence in the widest sense.

Taking Hann's values for the mean rate of precipitation and for the mean variation of water-vapour with height in the first kilometre the author obtains a value of $\xi = 1{\cdot}4 \times 10^5$ C.G.S. units.* Considering next the precipitation at $8{\cdot}5$ km., which consists of the slow descent of cirrus, cirro-stratus, and cirro-cumulus, he decides that ξ at that height must be between 3 and 180 C.G.S. units. The results depend on mean values taken over the whole earth over a long interval of time.

Comparison of the values of Richardson's results with those of other investigators is of interest. The values of ξ obtained from such methods as the variation of diurnal range of temperature, change of wind direction between the top and bottom of the Eiffel Tower, and the height at which the wind attains the gradient velocity and direction all give values of ξ between $1{\cdot}1 \times 10^5$ and $1{\cdot}45 \times 10^5$, while for the rate of vertical diffusion of temperature-inversions over the sea Taylor obtained the value $\xi = 3{\cdot}6 \times 10^3$.

The variation of turbulence with height is of especial interest. The evidence of the results of different writers is that the turbulence increases rapidly near the ground, reaches a maximum, and then falls off more slowly with increasing height, Richardson's values at $8{\cdot}5$ km. receive some confirmation from Schmidt's value of the "Austausch" at 10 km. which would give a value of $0{\cdot}5$ for ξ at that height.

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* The dimensions of ξ are those of [pressure]^2 [time]$^{-1}$ and since the millibar is 10^3 C.G.S. units of pressure, $1{\cdot}4 \times 10^5$ C.G.S. units of $\xi = 0{\cdot}14$ [millibar]^2/second. Near the ground a millibar is the difference of presence for about 8 metres, and the given value of ξ corresponds with the moment of velocity of a particle moving with speed $0{\cdot}14 \times 8$ metres a second in a circle of radius 8 metres.

The Royal Meteorological Society.

THE December meeting of the Royal Meteorological Society was devoted to a discussion on visibility. The discussion was opened by Mr. F. J. W. Whipple who mentioned some of the earlier work on the subject, emphasizing the importance of the researches of Robert Aitken. In Meteorological practice "visibility" was synonymous with "horizontal range of vision." To obtain comparable results from observations at different places there should be the same sort of contrast between the objects which were to be looked for, and their backgrounds. The best way to satisfy this condition was to select black objects standing against the skyline.

The recent adoption of observations of range of vision as part of the routine at telegraphic stations had made comparisons between atmospheric conditions at different places possible. From tabulations of the data for certain periods during 1921 and 1922, the following conclusions had been drawn :—

(*a*) The system gives reasonably consistent results in contrast with the old vague definitions of fog, &c., which did not.

(*b*) The standards adopted by day and by night are in general agreement. No deduction as to diurnal variation of the opacity of the atmosphere can be made from the figures, however, as the methods of observing by day and by night are different.

(*c*) The improvement in visibility during the day in summer is general, being most marked in urban districts and almost disappearing at Eskdalemuir and Valencia.

(*d*) Visibility was generally better in summer 1921 than in 1920. Shoeburyness and Howden were exceptional in this respect, however.

(*e*) In winter the Atlantic seaboard, represented by Valencia Observatory, shows to advantage, but in summer there is little to choose between that region and south-east England.

Captain Sir David Wilson-Barker criticised the Visibility Scale set out in the *Marine Observer's Handbook*, pointing out that at sea objects are not scattered about at convenient distances and expressed the opinion that for marine purposes the division of atmospheric opacity into fog, mist, and haze would be sufficient. He would define a fog as of the same density throughout, with a clearly marked boundary, a mist as thinner and of variable density. Snow, fine rain and

dust also interfered with visibility at sea. He thought that some form of screen or Nicol prism might improve the visibility in mist.

Wing-Commander M. G. Christie said that aviators attached the greatest importance to meteorological reports and especially to reports of visibility. Fog was one of the last remaining weather-enemies of flying, and even that was not insuperable. Once you are in the air it is easy enough to fly in fog, and certain devices, such as the Noakes landing-gear, now make it possible to land in fog. The amount of fog near any place depends very largely on the amount and class of manufacturing that goes on. Mist is a great danger to flying at night, especially as lights rapidly become invisible. The slightest quantity of mist makes landing difficult, however well the ground is lit up. In Mesopotamia the shimmering of the air makes landing difficult at midday. In utilising reports it is desirable to take altitude into consideration, as the visibility from a high observation post may differ from that at a low-lying aerodrome in the neighbourhood. The altitude of the stations should therefore be mentioned in the reports. Mr. Whipple had suggested that when the range of visibility differed according to direction the observer should report the greatest range, but he (Wing-Commander Christie) considered that the pilot would prefer to have the mean of all directions, or perhaps even the worst visibility. It should also be noted that the pilot does not always require the visibility of solid objects against a sky-line —he also requires the visibility from the air of objects on the ground.

Dr. J. S. Owens discussed the conditions of visibility, physical and physiological; the physical conditions include illumination, the contrast of light and shade, colour, and finally the effect of the medium, but the physiological conditions are of equal importance.

There is a definite percentage difference in illumination between an object and background which must be exceeded before any contrast becomes visible; this contrast varies from about one-half to ten per cent. He pointed out that there was a close relation between the emission of smoke and the amount of haze or fog in London, with a regular 24-hourly cycle. He described the manner in which the smoke from chimneys was distributed about the country.

Mr. J. E. Clark gave an account of his visibility observations at Purley and in London, and then Sir Napier Shaw, as chairman, summarised the discussion, pointing out that there were evidently two distinct phases of the subject, visibility from the ground of solid objects against the skyline, and visibility from the air.

Correspondence.

To the *Editors*, "*Meteorological Magazine.*"

A Comparison between the Double Theodolite and Tail Methods of obtaining the Height of Pilot Balloons.

CAPT. DURWARD has undertaken a useful piece of work in making a comparison between the height of pilot balloons as deduced from two-theodolite observations and from the tail method of measurement. Both these methods have been in use for many years past, but users of each system have generally been too confident each in the advantages of his own method to undertake a comparison between the two.

The difference of 5 per cent. which Capt. Durward finds in your October number between the heights measured by the two methods seems to point to a systematic error and certainly needs further investigation. The suggested unravelling of the cotton might be either assisted or hindered by the spin of the tail. Were all tails constructed to spin in the same way? It might be better to use fine wire of a single strand which should be more constant in length. The value of the results given in the note would be increased if a frequency table were included showing the number of cases where the heights deduced by the two methods differed by various percentages.

It is noticeable that the heights reached by Capt. Durward's balloons in specified times were consistently low compared with the "height from formula" values. Probably the weight of the tail was not included with that of the balloon in the "W" of the formula when working out the speed of ascent. If it was included one would expect the actual heights to exceed those by formula as the steadying effect of the tail should lead to increased rate of ascent. It would be interesting to know whether such was the case.

J. S. DINES.

December 1921.

With regard to the points raised by Mr. J. S. Dines, I may mention that all the tails were constructed to spin the same way, and by their spinning they tended to unravel the thread. In further experiments in which two threads have been used for the tails the average error in the "tail method" height has been considerably less than 5 per cent. The error has

been still less (usually between 0 and 2 per cent. up to 4,500 ft. for a 30-ft. tail) when the apparent length of the tail has been measured by means of a graticule instead of by a moving cross-wire and a micrometer.

A frequency table showing the number of occasions in which the height computed by the tail method differed from the height computed by the double theodolite method by 0–2 per cent., &c., is given below. The figures found from the ascents in which a double thread was used are in *italics*.

Table showing the Number of Occasions in which the Height measured by the Tail Method differed by 0–2 per cent., &c., from the Height obtained by Two Theodolites.

Figures in Roman refer to tail ascents with single thread.
" " *italics* " " " double "

Minute.	0–2 per cent.		2–4 per cent.		4–6 per cent.		6–10 per cent.		>10 per cent.		No. of Cases.
	+	–	+	–	+	–	+	–	+	–	
1	1	1	..	..	..	..	3	0	3	2	10
	..	..	..	..	..	..	..	..	..	..	..
2	3	1	0	1	1	4	3	3	0	6	22
	0	*2*	*0*	*1*	*1*	*1*	*0*	*2*	*1*	*0*	*8*
5	2	3	3	4	0	3	0	4	0	2	21
	2	*1*	*1*	*1*	*1*	*4*	*0*	*2*	*0*	*1*	*13*
9	1	6	0	2	0	2	0	4	0	1	16
	1	*2*	*0*	*1*	*0*	*3*	*0*	*3*	..	..	*10*
13	..	..	0	1	1	1	0	4	..	..	7
	0	*3*	*0*	*1*	..	..	*0*	*2*	*1*	*0*	*7*

As to the significance of the theoretical rate of ascent of the balloons, it should be stated that the free-lift was adjusted in each case with a view to a rate of ascent of 500 feet per minute. The balloon balance was adjusted so as to give a free-lift L'_0, such that $L'_0 = L_0 + w$, L_0 being the free-lift appropriate to a balloon of the assigned weight W when without a tail, and w the weight of the tail.

On the theory that the eddy resistance of the tail can be neglected though the effect of the weight on the resultant buoyancy must be allowed for, the formula* for determining the free-lift L′ to be given to the balloon before the tail is attached is—

$$v = \frac{q\,(L' - w)^{\frac{1}{2}}}{(W + L')^{\frac{1}{3}}} \quad \text{- - - - - -} \quad (1)$$

* Computer's Handbook, Sec. II. 1. Second Edition, p. 4, Footnote $(L' = L + w)$.

Whilst my L'_0 was virtually derived from the equation—

$$v = \frac{q\,(L'_0 - w)}{(W + L'_0 - w)^{\frac{1}{3}}} \quad - \; - \; - \; - \; - \; - \quad (2)$$

If the rate of ascent v is in feet per minute and the weights are in grammes, then the value adopted for the factor q is 276.*

My L'_0 was chosen so as to give $v = 500$ in formula (2). Substituting my L'_0 for the L' of formula (1) would give $v = 488$, so that the discrepancy amounts to only 2 per cent.

The fact that balloons rise very slowly during the first few minutes of their ascent has been very noticeable here during the summer months. Perhaps the balloons are caught in descending currents for which the topography of the surrounding country is in some way responsible.

J. DURWARD.

Larkhill, Nov. 24th, 1921.

The Sun and the Weather.

IN his interesting article under the above heading Mr. R. M. Deeley writes: "From a study of barometric changes I shall attempt to show that the conditions in Great Britain during the long spell of dry hot weather in 1921 have been such as may be expected when the electronic bombardment (from the sun) is a mild one."

On the contrary, the auroral and magnetic phenomena of the present year would indicate not a mild, but a severe electronic bombardment. The series of magnetic disturbances, from May 12th to May 21st, constituted a storm of the very first magnitude, and a storm too, which in its protracted nature, has not been equalled since that of November 1882. This storm has been succeeded by magnetic disturbances, at each synodical rotation of the sun, even to the month of November. (*cf. Nature*, Oct. 27th, 1921.)

The storm of May was accompanied by a very remarkable aurora, both in the northern and southern hemispheres. According to the *Monthly Weather Review*, U.S.A., for July 1921, pp. 406–409, the aurora was witnessed from northern and central Europe, westward over the Atlantic, across the the United States, and far over the Pacific, reaching as far south as Apia, Samoa. One remarkable character about

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* See *M.O. Circular* No. 27.

this auroral display was that it was seen in extreme south latitudes with all the brilliancy usually observed in the north. The natural inference is that such a display denoted a very severe electronic solar bombardment. Even after five synodic rotations of the sun Major Lockyer observed an aurora, on September 28th–29th, which was connected with that of May 14th–15th. (*Nature*, October 6th, 1921.)

Finally, to judge from the horizontal component, the general magnetic field of the earth was more intense in 1921 than in 1920. A. L. CORTIE, S.J.

Stonyhurst College Observatory, December 30th, 1921.

Units for Meteorological Work.

IN the discussion of the value of new units in meteorological work, Mr. L. C. W. Bonacina* touches one point of vital interest to climatologists; namely, that the Fahrenheit degree is preferable to the Centigrade, "because one can disregard fractions in many instances where it would not be justifiable to do so with Centigrade degrees." This is correct; and climatologists have long felt the need of a smaller scale division than the Centigrade, and for that matter, even the Fahrenheit.

It may interest your readers to know that for six years we have been using at Blue Hill the Kelvin-kilograd scale. This scale has all the merits of the Absolute-Centigrade, plus the advantage of smaller scale divisions; oKk is the absolute zero, and the freezing point is 1,000 Kk. The temperature of water boiling under the pressure of 760 mm. in Lat. 45° comes out to be 1,367 Kk, whilst for the pressure 1 megadyne per square centimetre the boiling point is 1,365 Kk. The scale ratios are 1 Kk = 0°·491 F. = 0°·273 C.

On the new scale the thermal coefficient of expansion of air is 0·001, which replaces the awkward values 0·00367 or 0·002039 appropriate to the Centigrade and Fahrenheit scales. For example, if the velocity of sound in dry air at a specified temperature is required, and it is known that the velocity in dry air at the freezing point of water is 332·9 metres per second, the velocity at the specified temperature, say 1,043 Kk, is $332{\cdot}9 \times 1{\cdot}043^{\frac{1}{2}}$ or 340·0 metres per second. On the other hand, if the Fahrenheit scale had been used, the corresponding expression for the velocity of sound at 52°·6 F. would have given us $332{\cdot}9 \times (1 + 20{\cdot}6 \times {\cdot}002039)^{\frac{1}{2}}$ and brought us to the same answer but by a longer route.

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* *Meteorological Magazine*, 1921, p. 255.

Much more could be written, but I realise the limits of your space.

Let me, however, as the one who in 1908 first proposed the decimalisation of pressure, add, that the prime reasons for changing are economy of time and space, and greater accuracy.

ALEXANDER MCADIE.

Blue Hill Observatory, Readville, Mass., Nov. 3rd, 1921.

[In the list of "References for the Historical Development of the Question of Units for Meteorological Measurements," in the *Observer's Handbook*, 1915, p. 162, there are six references preceding that to Prof. McAdie's paper of 1908. The "bar" and its sub-multiples were used by Bjerknes and Sandström in working up balloon observations made on the "International Days" 1900–1903.—ED. M.M.]

Grounds for Forecasting a Mild Winter.

THERE is a curious relation between Rothesay rainfall (annual) and the Greenwich winter; after a very mild winter, high rainfall; after a very high rainfall, a mild winter. Thus, taking the latter case, I find that if the Rothesay rainfall reaches 55 in. or more, the Greenwich winter temperature is rarely under 38° F. (only one case in sixteen and that close to 38° F.). In the sixteen cases there were twelve warm winters to four cold. The rainfall this year, I think, will come into the category of 55 in. or over, so that a mild winter would seem likely.

[The average rainfall of Rothesay is about 48·6 in.; the mean temperature of the Greenwich winter, 39°·3 F.]

ALEX. B. MACDOWALL.

Bellevue, Bridge of Allan, Dec. 31st, 1921.

NOTES AND QUERIES.

The Effect of Vertical Currents on Gun-ranging.

IN a recent paper communicated to the Royal Meteorological Society, Mr. N. K. Johnson draws attention to the fact that, when convection currents are strong, single theodolite pilot balloon ascents give erroneous values of wind velocity and direction in the first few thousand feet.

During gunnery trials it is exceedingly important, if vertical currents be present, that their strength should be known. At Shoeburyness, the double theodolite method of pilot balloon observation is always used, as this advantage is

secured as well as the greatest possible accuracy with regard to wind values. When firing at low elevations, the displacement of the point of fall of a shell due to a given vertical wind is much greater than that due to a following or head wind of the same velocity. I have worked out some typical examples. In the case of a gun firing with muzzle velocity of 2,400 feet per second and "quadrant elevation" of 5°, *i.e.*, with a range of about 5 miles, a following wind of 10 feet per second increases the range by 8·1 yards whereas an ascending current of the same velocity increases the range by 48·5 yards, an effect nearly six times as great. For a quadrant elevation of 3°, the vertical wind displacement is more than 10 times as great as that due to a horizontal following wind of the same velocity.

In summer anticyclonic weather, vertical currents of 10 feet per second are by no means uncommon and the horizontal component of the wind may be of the order of 5 feet per second. If single theodolite pilot balloon observations are used the calculated displacement of the point of fall of the shell would be quite erroneous not only on account of the false wind velocity deduced from the observations, but because the presence of the vertical wind component would be ignored. Irregular increases in range are found when strong vertical currents are present, but it is always difficult to say over what area convection extends. For this reason vertical winds cannot be allowed for by the artilleryman in the same systematic way as the horizontal winds which do not vary greatly from point to point over a small area.

This irregularity of the vertical current makes the verification of the "small arc computation" a matter of much difficulty. Even after head wind, density, and elasticity effects have been allowed for, it cannot be said that the residuum of the displacement represents a vertical wind effect since there are small indefinite errors due to such factors as slight differences in the lapse rate of temperature, to yaw and to the wear of the gun.

The figures given above were arrived at by the usual step-by-step integration of the equations of motion of a projectile moving under the given conditions. They represent the values of the displacement under ideal conditions which, perhaps, do not often arise in actual practice. They indicate, however, how unexpected over-ranging may be accounted for by the presence of vertical current, and hence the importance of detecting the presence of such currents during artillery trials by the double theodolite method of pilot balloon observation. C. E. BRITTON.

The Estimation of Cloud Height from Observations of Humidity.

WITH reference to Mr. L. H. G. Dines's note in the September number of this magazine on the estimation of cloud height from humidity observations, some observations made some time ago on Salisbury Plain by Captain J. Durward are of interest. Mr. Dines's observations were mostly of the stratified clouds formed in winds blowing from the Atlantic. Captain Durward's refer to a single occasion when cumulus cloud was forming over the heated land. The day in question, August 12th, 1919, was very hot; four pilot balloon ascents were made at 8 h. 45 m., 10 h., 11 h., and 11 h. 45 m., G.M.T., the two-theodolite method being used.

The growth of convection currents during the morning was well marked, the rates of ascent of the four balloons being 550, 505, 655, and 700 feet per minute.

The sky was cloudless up to 11 h., but about 11 h. 15 m. cumulus began to form, and by 12 h. the sky was half covered, the cloud height as measured was 5,000 feet, and the temperature reported for that level was 52° F.

The temperature in the Stevenson screen at the time was 77·3° F., the dew point (determined by the strong-wind formula which was deemed appropriate to the circumstances), 56·7° F. Using a rule equivalent to that given by Mr. Dines for a well-stirred atmosphere, Captain Durward estimated the level of condensation as 4,750 feet and the corresponding temperature as 52° F. The agreement with observation is satisfactory.

Dust-raising Winds.

DR. E. H. Hankin, whose observations of the flight of birds are well known, has contributed to the *Memoirs of the Indian Meteorological Department* a study of dust-raising winds which should be consulted by all who are interested in the nature of turbulent motion in the atmosphere. The principal point made by Dr. Hankin is that the raising of dust in considerable quantities requires vigorous descending currents to dig into the ground and disturb it violently. Once the dust has been lifted it can be carried to great distances and may form large clouds with comparatively dust-free air beneath. Dr. Hankin classifies the manifestations of the dust-raising power, and discusses *seriatim* dust-devils, large dust columns, dust-curtains, primary dust-storms (in which the dust is raised locally), and derived dust-storms (in which the dust

has been brought from a distance). A curious feature of the dust-devils, which are vertical whirls in which the dust is concentrated in the centre, is that in the initial stages the central column is sometimes seen to be falling. It may be suggested that in such cases the whirling motion near the ground is more vigorous than at greater heights so that centrifugal force reduces the pressure in the core of the whirl at low levels more than is appropriate to allow for convectional ascent of air in the central column, and there is therefore a tendency for this central column to fall and for the air immediately surrounding it to gain in digging power. On the other hand, when the dust-devil is well established the bottom of the dust column is maintained at a considerable height—50 metres or more—above the ground. Dr. Hankin's observations of smoke show that the ascending current associated with a dust-devil may have a radius of 6 miles. Within this radius all dust-raising by the wind ceases.

If we may legitimately generalise these observations we arrive at the paradox that a whirlwind marks the stabilising of convection over a considerable area and reduces the turbulence of the motion by substituting steady flow for irregular eddies.

Evaporation from Large Expanses of Water.

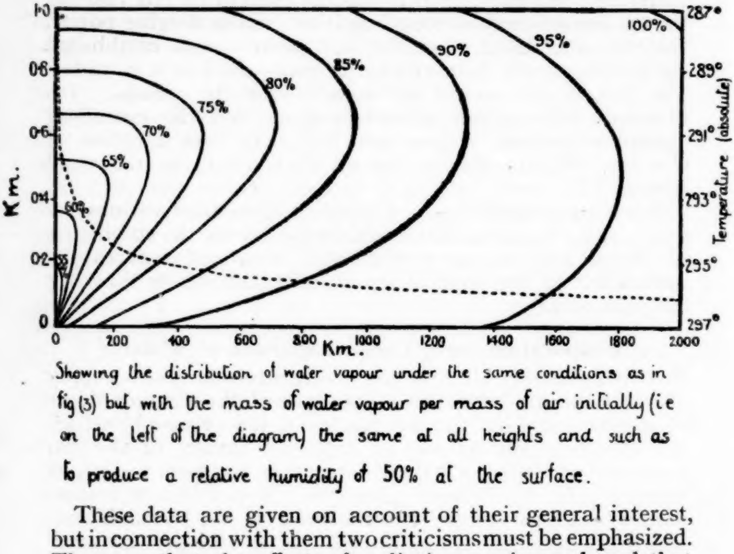
The fact that the air over the continents obtains its supply of water vapour from the oceans is one of the commonplaces of meteorology, but our knowledge of the process by which the vapour works its way up from the surface of the sea, gradually producing a state of saturation, has been too vague hitherto. Dr. H. Jeffreys submitted the problem to mathematical analysis in 1918, and the work of Mr. M. A. Giblett, which has been recently published,* marks a further advance. Dr. Jeffreys adopted the simple hypothesis that the rate of evaporation depended only on difference of vapour pressure, whilst Mr. Giblett allows for the strength of the wind.

The figure reproduced on p. 364 illustrates one of Mr. Giblett's examples.

The wind is blowing from left to right, and on the left of the diagram it reaches the ocean as a current with such water vapour as it contains thoroughly mixed with the air and with the relative humidity, at the surface, 50 per cent. The wind is 5 metres per second, *i.e.* Force 3 on the Beaufort Scale and the sea-temperature 75° F. It will be seen that

* *Some Problems connected with Evaporation from Large Expanses of Water.* By M. A. Giblett, M.Sc. *Proc. Roy. Soc.* A. Vol. 99, 1921.

according to the analysis, which is based on the experimental data of Dalton, Bigelow, and Richardson, the air near the sea reaches 90 per cent. humidity in about 300 kilometres (180 miles), but that evaporation then becomes slower and 95 per cent. humidity is not reached until nearly 1,400 kilometres (800 miles) have been covered; by that time all the air up to 3,000 feet has a relative humidity exceeding 90 per cent., and since the stirring of the air is never uniform, conditions are very favourable for the formation of low cloud.



Showing the distribution of water vapour under the same conditions as in fig (3) but with the mass of water vapour per mass of air initially (i.e. on the left of the diagram) the same at all heights and such as to produce a relative humidity of 50% at the surface.

These data are given on account of their general interest, but in connection with them two criticisms must be emphasized. These are that the effects of radiation are ignored, and that the lapse-rate of temperature is assumed to be 1° C. per 100 metres. Such a high lapse-rate, connoting thorough stirring of the atmosphere, is the rule over the land in the middle of a summer day. It is not generally appropriate for air over the sea.

The paper provides valuable information as to the total amount of evaporation under various conditions. It is interesting to notice that the same amount of air picks up less moisture if it crosses the ocean quickly than if it goes slowly; the more vigorous evaporation does not make up for the shorter time of passage.

The Smoke Veil.

An interesting example of atmospheric pollution is noted in *Nature* of December 15th by Mr. W. Lawrence Balls, of Bollington Cross, near Macclesfield. On November 26th Mr. Balls was walking from Hayfield to Edale across the Peak of Derbyshire. Below 1,550 feet on the western side he noted hazy sunshine with rime, but at 1,500 feet there was a thin cloud, with a temperature scarcely below freezing point, formed by a steady easterly wind blowing over the Peak plateau from the east. These conditions had obtained since the morning of the previous day, and hoar-frost of peculiar formation had resulted. The stream-lines of air-flow round stones was clearly shown by curling lines of ice, and the deposits of ice-crystals on grass, leaves, and stems took the form of knife-blades with the edges pointing up-wind. The largest ice-knife, which was nearly an inch in width, showed, even at a distance of 2 or 3 yards, a regular striped pattern, and on closer inspection the stripes were found on all the knives. The stripes were three in number, pale grey near the leaf and towards the edge of the knife, and clear or yellowish in between. The grey stripes were evidently due to the presence of smoke in the cloud-mist during the day on November 25th and 26th, while the clear zone had been formed during the night when the wind was cleaner. At Edale Cross, 1,750 feet above sea level, the knives pointed their edges directly to the centre of Sheffield—the intervening distance is more than 16 miles, the first 14 of which are wild moorland.

An Exhibition of Scientific Instruments.

At the annual exhibition of scientific apparatus organised by the Physical Society and the Optical Society, Messrs. Negretti and Zambra and Messrs. Casella exhibited various instruments of interest to meteorologists. Messrs. Negretti and Zambra showed several forms of "transmitting thermometers," thermometers actuated by the expansion of mercury in steel. The thermographs constructed on this principle should prove of great value, as the thermometer bulb can be exposed in a screen out of doors whilst the chart is in view in the house. Messrs. Casella exhibited a weathercock with a vane of the Meteorological Office pattern and the Owens autographic air filter. Both these firms exhibited self-recording rain gauges. Kew unifilar magnetometers were shown by Casella and by the Cambridge and Paul Instrument Company. The latter company also exhibited a Dip Circle of the Kew pattern.

Display of Meteorological Information for the London-Continental Aerial Routes at Lympne Aerodrome.

PILOTS on the London-Continental Air Routes when flying towards London, can obtain information as to the existing weather conditions at their destination by means of a system of ground signals which has been established at Lympne Aerodrome. These consist of large white letters and figures placed in a convenient position and denoting, according to fixed scales, the cloud height and visibility (and also, when reported, adverse weather such as snow or gales) at Biggin Hill and Croydon. These signals will shortly be extended to include the weather conditions at St. Inglevert for the information of pilots proceeding from England to the Continent.

Radiation from the Sky.

RADIATION MEASURED AT BENSON, OXON, 1921.

Unit: one gramme calorie per square centimetre per day.

ATMOSPHERIC RADIATION only (dark heat rays). Averages for Readings about time of Sunset.		Oct.	Nov.	Dec.	Year.
Cloudless days :—					
Number of readings	n	12	13	13	*†
Radiation from sky in zenith	πI	517	436	468	499
Total radiation from sky	J	549	457	509	538
Total radiation from horizontal black surface on earth.	X	717	601	656	708
Net radiation from earth	$X—J$	168	144	147	170
DIFFUSE SOLAR RADIATION (luminous rays). Averages for Readings between 9 h. and 15 h. G.M.T.					
Cloudless days :—					
Number of readings	n_0	8	4	3	*
Radiation from sky in zenith	πI_0	24	22	18	44
Total radiation from sky	J_0	28	27	28	50
Cloudy days :—					
Number of readings	n_1	4	9	11	*
Radiation from sky in zenith	πI_1	91	50	28	138
Total radiation from sky	J_1	73	43	23	126

* Mean of 12 monthly values.
† June interpolated (565, 600, 770, 170).

"Fine" or "Fair."

FOR many years the Meteorological Office has adopted conventional meanings for the words "fine" and "fair" as applied

to weather, but it is not certain that the same meanings are attached to the words by the public. The Director would be glad to receive from readers of the Magazine definitions of the words in question as understood by the general public.

Obituary.

The Rev. John Smith Begg, M.A., Rector of St. Olaf's Church, Kirkwall, Orkney, who died on 14th December 1921, at the age of 46, had rendered considerable services to meteorology in Scotland. A native of Perth, he was educated mainly at Edinburgh where he entered the University with the high distinction of "First Bursar," and graduated with honours in mathematics and natural philosophy. From his student days onwards he took a keen interest in meteorology and on many vacations he acted as a voluntary observer on Ben Nevis. Mr. Begg's career as a clergyman of the Episcopal Church in Scotland took him successively to West Linton (1907–1913) and to Kirkcaldy (1913–1918); at each place he established a climatological station and secured its continuance, whilst at West Linton a small research grant enabled him to carry out an investigation into the question of temperature gradients with different types of weather. He resigned his charge at Kirkcaldy in order to accept a commission in the Royal Air Force in 1918, and after a period of training was posted as Meteorological Officer at Longside Airship Station. On demobilization in September 1919 and election to his charge at Kirkwall, he took over the duties of climatological observer at that place.

Mr. Begg was not a physically robust man; but his eager spirit was never daunted, and he will be remembered as representing the best type of the voluntary worker to whom this country has owed so much.

Mr. P. C. Steventon.—We note with regret the death of Mr. P. C. Steventon, meteorologist to the Borough of Torquay, at the early age of twenty-nine. Mr. Steventon succeeded Mr. F. March who retired from the position of Borough Meteorologist in December 1919, and proved an enthusiastic and conscientious worker. His health had been affected, however, by the strain of military service, and he succumbed to a short illness.

News in Brief.

CASES for binding the Meteorological Magazine, 1921, will be available shortly. They are to be obtained for one shilling (plus postage *2d.*) from H.M. Stationery Office, Imperial House, Kingsway, W.C. 2.

In the programme of the Royal Institution two lectures by Sir Napier Shaw, F.R.S., on "Droughts and Floods" are announced. These lectures will be delivered on Thursdays, February 2nd and 9th, at 3 p.m.

A discussion on "The Use of Light as an Aid to Aerial Navigation" will be opened by Lt.-Col. L. F. Blandy at the next meeting of the Illuminating Engineering Society, which is to be held at 8 p.m. on January 31st at the house of the Royal Society of Arts, John Street, Adelphi. The chair will be taken by Maj.-Gen. Sir Frederick Sykes, the Controller-General of Civil Aviation.

There was an unusually large number of earthquake shocks during December. They occurred in the Eastern Alps, Lake Bolsena (north of Rome), in the Andes, and at Tokyo. The latter, which occurred on the night of the 8th, was the severest for twenty years. No deaths are reported, but several injuries and much material damage. The water-main was broken, and the entire city was without water for two days.

The Weather of December, 1921.

December 1921 was a typically unsettled month throughout the greater part of western Europe. At the beginning, pressure was high over Scandinavia, and depressions from the Atlantic moved south-eastwards across the Bay of Biscay to Spain and the Mediterranean, causing heavy rainfall in those regions: 79 mm. fell at Brest and 80 mm. at Sanguinaire, in Corsica, on the 1st, 42 mm. at Rome on the 2nd, while another 70 mm. were measured at Sanguinaire during the 2nd and 3rd.

By the 4th the anticyclone over Scandinavia had begun to withdraw towards central Europe, and depressions near Iceland and Spitzbergen extended their influence to Norway and the north-west districts of the British Isles; varying quantities of rain (or snow in the Arctic circle) fell on many days in succession, but the measurements were generally well under 15 mm. although that figure was exceeded occasionally, *e.g.*, 24 mm. at Eskdalemuir and 22 mm. at Skudesnaes, both on the 6th. Meanwhile the barometer had been falling in central Europe and there was but a comparatively narrow wedge over France and Austria extending from the anticyclone near the Azores. This favoured the development of a small secondary depression over southern Norway which caused rainfall in the neighbourhood of the Baltic on the 7th. For the next few days pressure remained high near the

White Sea and "lows" prevailed north-westwards from the Mediterranean and Poland to Spitzbergen and thence south-westwards a thousand miles or so beyond Iceland. Snow fell in Norway and Sweden and rain at times in most parts with the exception of a small area in the extreme south-west which was dominated by the anticyclonic ridge extending from the Azores. The main flow of air on the northern side of this ridge brought mild, damp weather to the British Isles with night temperatures ranging generally between 40° F. and 50° F. Rainfall, however, was scanty in most districts.

Gradually the anticyclone from the north of Russia moved southwards and uniting with the extension of the Azores system formed an irregular belt of high pressure across the centre of the continent. In eastern and central Europe there was a marked drop in temperature about the 11th or 12th, the thermometer falling several degrees below zero at night both at Prague and Lemberg. Light north-westerly winds in the rear of shallow secondary depressions near the English Channel caused perceptibly colder weather in many parts of England also; frost occurred locally in the screen on the 12th, 13th, and 14th and there was some fog as also in Denmark and the Netherlands where it developed frequently during this period.

After the middle of the month pressure was high near Spitzbergen for about a week and depressions from the Icelandic region therefore tended to pass east or south-east to southern Scandinavia causing frequent gales over a large area, including the British Isles, the North Sea, Denmark, and the Baltic. With the increased gradient for westerly winds temperature rose, especially in the southern districts, and there was little or no frost in the British Isles from the 17th to 20th. Throughout the night of the 18th–19th the thermometer never fell below 50° F. in many parts of south-eastern and southern England and remained two or three degrees above that figure in some localities including Kew.

Gales were reported between Iceland and the Hebrides on the 16th and subsequently, as the depression deepened over southern Norway, the circulation became very strong near Denmark and the southern Baltic and did not subside until the 19th by which time Atlantic liners approaching our coasts were encountering fresh westerly gales as another depression passed south of Iceland. Rough weather was renewed in north-western Europe and strong gales experienced near the Shetlands and Skagerrak. Precipitation associated with these depressions was not, generally speaking, particularly heavy although on the morning of the 17th, 43 mm.

was reported as falling at Floro in southern Norway.

Troughs of low pressure secondary to the main system in the north developed off our south-west coasts and caused steep gradients in the neighbourhood of the English Channel with gales locally on the 22nd and 23rd. Rain fell over a very wide area but seldom much exceeded 10 mm. except in the Mediterranean where a shallow depression yielded 54 mm. at Sanguinaire on the 23rd–24th.

On Christmas Eve there was a temporary drop in temperature in England and many parts of western Europe as the result of cold north-westerly winds associated with a ridge of high pressure which had spread up from the Azores. Ground frost was fairly general, but there was little or none in the screen except in Sweden and the extreme north. Before night the winds had backed again with the approach of a minor disturbance which caused temperature to rise again to 50° F. or above in southern England on Christmas Day, but in its rear a wedge of high pressure spread over the English Channel and northern France occasioning local fog and sharp frost inland the next morning.

Cyclonic conditions, however, prevailed again almost immediately with rain at times in most districts. In the north and west heavy falls were recorded; 43 mm. at Eskdalemuir, 31 mm. at Oxo and over 20 mm. at Floro and Valencia. The last few days of the month were characterised by renewed high winds and gales near the Bristol Channel, English Channel, southern North Sea and south-western Baltic. At 1 h. on the 28th the westerly current attained the force of a whole gale (over 55 miles per hour) at Plymouth and the general strength of the wind was such as to reach gale force, in gusts at least, at inland stations also. On the 30th the passage of a depression across the north of Scotland to southern Norway was accompanied by violent gales which swept across the British Isles during the day and night. Gusts between 55 and 60 miles per hour were recorded at Kew Observatory, between 60 and 70 miles per hour at Benson and Scilly and over 75 miles per hour at Holyhead. As regards the British Isles as a whole this was probably the roughest day of the month and was the occasion of considerable damage to property. During this period there was more heavy rain, snow and hail in south-west Scotland, about 25 mm. being recorded at Eskdalemuir on three days in succession. On the Continent measurements occasionally exceeded 10 mm. but precipitation was more generally light.

L. D. S.

In central and southern Europe the drought of the preceding months continued, and the level of the Rhine was unusually low. In Switzerland the weather was fine and mild and the snow-cover thin until about the 24th, when heavy falls of snow enabled winter sports to begin. On the 29th rain fell for a time, with remarkably high temperatures for the time of year, even at high levels. In the Italian Alps and the northern half of Italy the drought has now become very severe. The electric plants, which are worked by water power, have had to close down. In Genoa, on the 19th, water was being sold at *2d.* a gallon, and there have been several forest fires. In the Trentino the water of a lake has fallen so much that a small island has appeared which has not been seen since the great drought of 1806. This year, however, has exceeded the conditions of 1806, and Father Gaddoni, of Imola, is reported as saying that one must go back to 1621 to find another drought in the Po Valley similar to the present one.

The southern parts of Italy were, however, well supplied with rain, and at Bari, in Apulia, damage has been done by the heavy rainfall.

There was heavy snowfall in Asia Minor, and towards the end of the month a gale in the Black Sea, but it appears that in most parts of Russia the drought continues. Welcome winter rains have fallen over wide areas in Baluchistan and North-west India.

In North America a severe gale occurred on the Newfoundland coast on the 7th, in connection with a depression which moved north-eastward across the Maritime Provinces. Several vessels were wrecked, two with loss of life. Another deep depression which moved westward across Canada lay off Nova Scotia on the 12th, causing gales, though hitherto no damage has been reported.

A violent tornado was experienced in the northern parts of Arkansas and Mississippi on the 23rd, followed by a severe frost. The death-roll numbered thirty-six. A gale occurred at San Francisco on the 25th, also causing loss of life.

A message from Australia on December 28th reports extremely heavy rains, ranging from 6 to 12 inches, in New South Wales and Queensland. Flooded rivers and wash-aways seriously interfered with traffic, but the rain will be very beneficial to agriculture.

A telegram from Dr. Sampaio Ferraz, of Brazil, states that during December the rainfall was deficient in the centre and south of Brazil, and the temperature was generally above normal but no excessive heat was experienced, and there was an unusual lack of thunderstorms over the country. The

(*Continued on* p. 376.)

Rainfall Table for December 1921.

STATION.	COUNTY.	Aver. 1881–1915.	1921.		Per cent. of Av.	Max. in 24 hrs.		No. of Rain Days.
		in.	in.	mm.		in.	Date.	
Camden Square	London	2·39	1·13	29	47	·21	14	15
Tenterden (View Tower)	Kent	3·11	1·96	50	63	·37	14	19
Arundel (Patching Farm)	Sussex	3·36	2·28	58	68	·56	22	15
Fordingbridge (Oaklands)	Hampshire	3·96	2·01	51	51	·35	30	19
Oxford (Magdalen College)	Oxfordshire	2·32	1·28	33	55	·25	22	16
Wellingborough (Swanspool)	Northampton	2·35	1·60	41	68	·28	26	16
Hawkedon Rectory	Suffolk	2·42	1·46	37	60	·25	26	16
Norwich (Eaton)	Norfolk	2·61	1·96	50	75	·37	23	15
Launceston (Polapit Tamar)	Devon	5·12	3·41	87	67	·75	22	27
Sidmouth (Sidmount)	„	3·93	1·60	41	41	·31	22	18
Ross (County Observatory)	Herefordshire	2·97	1·59	41	54	·40	26	14
Church Stretton (Wolstaston)	Shropshire	3·36	2·97	75	88	·53	30	19
Boston (Black Sluice)	Lincoln	2·15	1·36	35	63	·40	24	16
Worksop (Hodsock Priory)	Nottingham	2·36	1·80	46	77	·34	24	19
Mickleover (Clyd House)	Derbyshire	2·63	2·03	52	77	·40	27	20
Southport (Hesketh Park)	Lancashire	3·23	3·84	98	119	1·06	27	25
Harrogate (Harlow Moor Ob.)	York, W. R.	2·92	3·83	97	131	·37	24	25
Hull (Pearson Park)	„ E. R.	2·41	2·28	58	95	·77	27	18
Newcastle (Town Moor)	North'land	2·41	1·56	40	65	·21	18	15
Borrowdale (Seathwaite)	Cumberland	16·34	22·10	561	135	..	..	..
Cardiff (Ely Pumping Stn.)	Glamorgan	5·11	2·70	69	53	·51	26	26
Haverfordwest (Gram. Sch.)	Pembroke	5·70	3·00	76	53	·58	26	24
Aberystwyth (Gogerddan)	Cardigan	5·03	5·29	134	105	·77	26	20
Llandudno	Carnarvon	3·10	3·06	78	99	·58	24	21
Dumfries (Cargen)	Kirkcudbrt.	5·41	6·27	159	116	·88	6	23
Marchmont House	Berwick	2·81	2·62	67	93	·68	30	20
Girvan (Pinmore)	Ayr	5·99	8·22	209	137	·78	6	27
Glasgow (Queen's Park)	Renfrew	4·23	5·79	147	137	·78	26	26
Islay (Eallabus)	Argyll	5·93	8·86	225	149	1·16	21	30
Mull (Quinish)	„	7·13	8·04	204	113	·71	29	28
Loch Dhu	Perth	10·08	13·90	353	138	1·50	31	26
Dundee (Eastern Necropolis)	Forfar	2·66	1·46	37	55	·34	21	14
Braemar (Bank)	Aberdeen	3·57	3·01	77	84	·60	29	23
Aberdeen (Cranford)	„	3·48	1·64	42	47	·45	4	18
Gordon Castle	Moray	2·69	2·90	74	108	·45	30	22
Fort William (Atholl Bank)	Inverness	10·08	15·40	391	153	2·14	5	26
Alness (Ardross Castle)	Ross	4·13	6·00	152	145	·79	30	23
Loch Torridon (Bendamph)	„	10·20	15·01	381	147	1·54	31	27
Stornoway	„	6·25	8·66	220	139	·69	6	28
Loch More (Achfary)	Sutherland	9·24	16·87	429	183	2·25	6	28
Wick	Caithness	3·08	4·14	105	134	·50	5	26
Glanmire (Lota Lodge)	Cork	5·50	2·25	57	41	·33	26	23
Killarney (District Asylum)	Kerry	7·28	3·89	99	53	·63	26	27
Waterford (Brook Lodge)	Waterford	4·69	1·90	48	41	·30	10	20
Nenagh (Castle Lough)	Tipperary	4·61	4·40	112	95	1·00	26	28
Foynes (Coolnanes)	Limerick	4·73	3·73	95	79	..	..	..
Gorey (Courtown House)	Wexford	3·82	1·38	35	36	·34	27	16
Abbey Leix (Blandsfort)	Queen's Co.	3·68	3·33	85	90	·63	27	25
Dublin (FitzWilliam Square)	Dublin	2·48	2·46	63	99	·92	27	18
Mullingar (Belvedere)	Westmeath	3·68	3·68	93	100	·70	27	27
Woodlawn	Galway	4·45	4·56	116	102	·69	27	30
Crossmolina (Enniscoe)	Mayo	6·55	5·97	152	91	·61	21	27
Collooney (Markree Obsy.)	Sligo	4·79	4·61	117	95	·42	24	28
Seaforde	Down	4·12	2·99	76	73	·47	26	21
Ballymena (Harryville)	Antrim	4·44	4·33	110	98	·35	4	27
Omagh (Edenfel)	Tyrone	4·23	6·00	152	142	·72	29	29

Ennistymon House, Nov., 4·96 in. 126 mm.

Supplementary Rainfall, December 1921.

Div.	STATION.	RAIN. in.	RAIN. mm.	Div.	STATION.	RAIN. in.	RAIN. mm.
II.	Ramsgate	1·04	26	XII.	Langholm, Drove Rd.	9·48	241
,,	Sevenoaks, Speldhurst	1·97	50	XIII.	Ettrick Manse	9·93	252
,,	Hailsham Vicarage	3·17	81	,,	North Berwick Res.	2·02	51
,,	Totland Bay, Aston	1·70	43	,,	Edinburgh, Royal Ob.	3·13	79
,,	Ashley, Old Manor Ho.	1·49	38	XIV.	Biggar	5·40	137
,,	Grayshott	2·25	57	,,	Leadhills	11·87	301
,,	Ufton Nervet	1·77	45	,,	Maybole, Knockdon	7·63	194
III.	Harrow Weald, Hill Ho.	1·47	37	XV.	Dougarie Lodge	7·79	198
,,	Pitsford, Sedgebrook	1·68	43	,,	Inveraray Castle	17·89	454
,,	Chatteris, The Priory	·98	25	,,	Holy Loch, Ardnadam	14·22	361
IV.	Elsenham, Gaunts End	1·65	42	,,	Oban	8·06	205
,,	Lexden, Hill House	1·17	30	XVI.	Loch Venachar	7·50	191
,,	Aylsham, Rippon Hall	2·29	58	,,	Glenquey Reservoir	9·20	234
,,	Swaffham	1·35	34	,,	Loch Rannoch, Dall	8·65	220
V.	Devizes, Highclere	1·78	45	,,	Blair Atholl	5·03	128
,,	Weymouth	1·55	39	,,	Coupar Angus	1·80	46
,,	Ashburton, Druid Ho.	3·13	79	,,	Montrose Asylum	1·17	30
,,	Cullompton	2·38	61	XVII.	LogieColdstone,Loanh'd	1·99	51
,,	Hartland Abbey	2·78	71	,,	Fyvie Castle	1·83	47
,,	St. Austell, Trevarna	2·92	74	,,	Grantown-on-Spey	3·72	95
,,	Crewkerne Merefield Ho	1·93	49	XVIII.	Cluny Castle	7·63	194
,,	Cutcombe, Wheddon Cr.	4·49	114	,,	Loch Quoich, Loan	40·60	1,031
VI.	Clifton, Stoke Bishop.	2·34	59	,,	Fortrose	4·03	102
,,	Ledbury, Underdown.	1·25	32	,,	Faire-na Squir	10·75	273
,,	Shifnal, Hatton Grange	1·95	49	,,	Skye, Dunvegan	11·70	297
,,	Ashbourne, Mayfield	2·83	72	,,	Glencarron Lodge	18·57	472
,,	Barnt Green, Upwood	1·66	42	XIX.	Dornoch, St. Gilberts	3·90	99
,,	Blockley, Upton Wold	1·89	48	,,	Tongue Manse	6·47	164
VII.	Grantham, Saltersford	1·23	31	,,	Melvich Schoolhouse	6·94	176
,,	Louth, Westgate	1·67	42	XX.	Dunmanway Rectory	4·45	113
,,	Mansfield, West Bank	2·41	61	,,	Mitchelstown Castle	2·90	74
VIII.	Nantwich, Dorfold Hall	2·63	67	,,	Gearahameen	10·50	267
,,	Bolton, Queen's Park.	6·68	170	,,	Darrynane Abbey	2·68	68
,,	Lancaster, Strathspey.	6·04	153	,,	Lismore Castle	1·76	45
IX.	Rotherham, Moorgate.	2·77	70	,,	Cashel, Ballinamona	2·19	56
,,	Bradford, Lister Park.	4·89	124	,,	Roscrea, Timoney Pk.	3·28	83
,,	West Witton	4·50	114	,,	Ballybunion	3·59	91
,,	Scarborough, Scalby	2·31	59	,,	Broadford, Hurdlesto'n	4·87	124
,,	Middlesbro', Albert Pk.	1·96	50	XXI.	Kilkenny Castle	1·13	29
,,	Mickleton	6·90	175	,,	Rathnew, Clonmannon	1·93	49
X.	Bellingham	4·88	124	,,	Hacketstown Rectory	2·22	56
,,	Ilderton, Lilburn	1·62	41	,,	Balbriggan, Ardgillan	2·37	60
,,	Orton	12·61	320	,,	Drogheda	1·79	45
XI.	Llanfrechfa Grange	3·20	81	,,	Athlone, Twyford	4·17	106
,,	Treherbert, Tyn-y-waun	9·80	249	XXII.	Castle Forbes Gdns.	3·78	96
,,	Carmarthen Friary	3·78	96	,,	Ballynahinch Castle	7·56	192
,,	Llanwrda, Dolaucothy	5·95	151	,,	Galway Grammar Sch.	5·56	141
,,	Lampeter, Falcondale	4·46	113	XXIII.	Westport House	5·36	136
,,	Cray Station	9·50	241	,,	Enniskillen, Portora	4·79	122
,,	B'ham W.W., Tyrmyndd	6·70	170	,,	Armagh Observatory	3·27	83
,,	Lake Vyrnwy	10·79	274	,,	Warrenpoint	2·54	65
,,	Llangynhafal, P. Drâw	3·60	91	,,	Belfast, Cave Hill Rd.	3·63	92
,,	Oakley Quarries	15·19	386	,,	Glenarm Castle	4·27	109
,,	Dolgelly, Bryntirion	7·25	184	,,	Londonderry, Creggan.	5·81	148
,,	Snowdon, L. Llydaw.	20·54	522	,,	Sion Mills	5·73	145
,,	Lligwy	4·70	119	,,	Milford, The Manse	6·03	153
XII.	Stoneykirk, Ardwell Ho.	3·59	91	,,	Narin, Kiltoorish	5·85	149
,,	Carsphairn, Shiel	13·96	355	,,	Killybegs, Rockmount	9·85	250

Climatological Table for the

STATIONS	PRESSURE		TEMPERATURE							
	Mean M.S.L.	Diff. from Normal	Absolute				Mean Values			
			Max.	Date	Min.	Date	Max.	Min.	½ max. and min.	Diff. from Normal
	mb.	mb.	° F.		° F.		° F.	° F.	° F.	° F.
London, Kew Observatory	1018·0	+2·5	89	10	46	1	78·8	57·7	68·3	+5·6
Gibraltar	1016·6	+1·3	86	23, 25, 31	62	16	81·0	67·7	74·3	−0·4
Malta	1015·5	+1·5	99	20	70	8	84·6	73·3	78·9	+1·6
Sierra Leone	1014·2	+0·9	88	3, 8, 25	64	8	84·8	71·4	78·1	−0·8
Lagos, Nigeria	1015·0	+1·2	86	8	69	16	80·1	74·0	77·1	−0·2
Kaduna, Nigeria	1014·5	+2·7	91	29, 31	62	4	82·1	66·5	74·3	−0·3
Zomba, Nyasaland	1019·0	+1·1	81	19	47	24	69·5	51·6	60·5	−1·2
Salisbury, Rhodesia	1020·2	−0·7	77	20	37	6	69·7	42·1	55·9	−0·2
Cape Town	1023·5	+2·2	77	12	35	20	61·6	45·1	53·3	−1·6
Johannesburg	1026·0	−0·5	65	19	30	7	57·4	37·2	47·3	−3·3
Mauritius	..	..	..	..	..	..	..	..	..	..
Bloemfontein	..	..	69	17	16	2	58·4	27·9	43·1	−4·2
Calcutta, Alipore Obsy.	999·9	+0·7	94	20	75	11	89·3	79·4	84·3	+0·8
Bombay	1002·8	−0·9	90	6	75	20	84·3	77·5	80·9	−0·2
Madras	1003·9	−0·6	102	2	72	19	93·2	77·8	85·5	−1·8
Colombo, Ceylon	1008·6	+0·5	88	5	72	17	86·7	77·3	82·0	+0·7
Hong Kong	1006·9	+2·0	91	23	73	6	86·2	77·8	82·0	−0·5
Sandakan	..	..	91	5, 24	73	13, 15, 31	87·9	75·2	81·5	−0·4
Sydney	1016·7	−1·8	75	16	43	5	65·3	49·4	57·3	+4·9
Melbourne	1016·2	−2·7	66	11	33	23	57·1	43·4	50·3	+1·7
Adelaide	1018·5	−1·9	68	16	40	6	61·8	46·9	54·3	+2·7
Perth, Western Australia	1018·2	−0·9	76	21	41	29	65·1	52·5	58·8	+3·8
Coolgardie	1019·2	−0·7	71	6	30	29	64·8	43·3	54·1	+2·9
Brisbane	1016·9	−1·3	77	17	47	16	70·2	53·9	62·1	+3·8
Hobart, Tasmania	1009·6	−4·1	65	4	32	31	54·1	41·9	48·0	+2·6
Wellington, N.Z.	1014·6	+1·7	60	14	30	11	53·7	43·1	48·4	+0·9
Suva, Fiji	1015·2	+1·0	84	27, 29, 31	58	14	79·9	60·6	70·3	−3·3
Kingston, Jamaica	1014·9	+0·2	93	25	69	5	89·3	73·5	81·4	−0·3
Grenada, W.I.	1014·3	+1·0	90	24	72	5, 12	85·3	74·7	80·0	+1·1
Toronto	1014·8	+1·1	98	5	59	22	88·1	67·6	77·9	+9·7
Winnipeg	1013·6	+0·9	94	9	49	25	81·9	59·0	70·5	+4·3
St. John, N.B.	1014·8	+1·1	80	27	48	5	69	54	61·5	+1
Victoria, B.C.	1019·8	+3·1	77	22	47	9	64·8	50·5	57·7	−2·6

London, Kew Observatory.—Mean speed of wind 7·2 mi/hr; 1 day with thunder heard.

Malta.—Prevailing wind direction NW. From this month max. temp. refers to the period 7 h. to 18 h. and min. temp. 18 h. to 7 h.

Sierra Leone.—Prevailing wind direction SW, 2 days with thunder heard, 1 day with gale.

Madras.—11 days with thunder heard.

Colombo, Ceylon.—Prevailing wind direction WSW, mean speed 6·6 mi/hr.

Hong Kong.—Prevailing wind direction ESE; mean speed 11·0 mi/hr; 4 days with thunder heard.

Mauritius :—										
January 1921	1012·0	+0·1	88	7	67	20	84·4	71·8	78·1	−1·2
February	1010·3	−0·7	88	3	70	1, 28	83·1	73·6	78·3	−1·0
March	1012·6	+0·6	86	16	69	29	82·8	73·2	78·0	0·0
April	1014·7	+0·7	84	10	61	28	81·0	67·1	74·1	−1·7

Mauritius :—January, Prevailing wind direction E, mean speed 7·4 mi/hr. February Prevailing wind direction E, mean speed 10·1 mi/hr.

British Empire, July 1921.

TEMPERATURE Mean Wet Bulb. °F.	TEMPERATURE Absolute Min. on Grass °F.	Relative Humidity %	Mean Cloud Am'nt 0–10	PRECIPITATION Amount in.	PRECIPITATION Amount mm.	PRECIPITATION Diff. from Normal mm.	PRECIPITATION Days	BRIGHT SUNSHINE Hours per day	BRIGHT SUNSHINE Percentage of possible	STATIONS
60·8	40	55	5·2	0·15	4	− 51	5	8·3	51	London, Kew Observatory.
69·5	61	79	3·1	0·00	0	− 1	0	..	..	Gibraltar.
71·1	65	61	1·1	0·00	0	− 1	0	11·6	81	Malta.
74·3	..	79	7·7	22·36	568	−305	26	..	..	Sierra Leone.
74·5	66	85	9·5	16·86	428	+159	25	..	..	Lagos, Nigeria.
70·3	..	93	..	11·10	282	+ 50	19	..	..	Kaduna, Nigeria.
..	..	81	4·1	0·92	23	+ 16	7	..	..	Zomba, Nyasaland.
48·6	29	56	2·8	0·04	1	0	1	..	..	Salisbury, Rhodesia.
49·3	..	72	4·6	4·25	108	+ 18	15	..	..	Cape Town.
36·2	27	55	0·5	0·00	0	− 6	0	9·8	92	Johannesburg.
..	..	..	..	..	..	..	..	..	..	Mauritius.
33·5	..	73	1·5	0·00	0	− 10	0	..	..	Bloemfontein.
80·7	72	76	8·8	9·66	245	− 82	12*	..	..	Calcutta, Alipore Obsy.
77·6	69	83	8·7	35·67	906	+267	29*	..	..	Bombay.
76·4	..	78	8·0	8·36	212	+108	10*	..	..	Madras.
77·6	68	71	8·6	5·12	130	0	13	..	..	Colombo, Ceylon.
77·3	..	80	6·1	11·88	302	− 17	15	8·3	63	Hong Kong.
75·8	..	79	..	6·75	171	+ 5	13	..	..	Sandakan.
52·6	36	68	4·6	7·03	179	+ 57	11	5·3	52	Sydney.
47·5	30	76	6·5	2·41	61	+ 15	15	..	..	Melbourne.
50·3	29	74	5·0	2·01	51	− 16	12	4·6	46	Adelaide.
54·8	35	71	6·2	7·39	188	+ 21	19	..	..	Perth, Western Australia.
50·1	25	55	3·9	0·24	6	− 17	4	..	..	Coolgardie.
57·8	36	70	4·5	6·14	156	+ 98	10	..	..	Brisbane.
43·7	26	73	6·2	4·47	114	+ 60	18	4·3	46	Hobart, Tasmania.
45·9	22	82	7·5	4·61	117	− 27	16	3·2	34	Wellington, N.Z.
71·5	..	90	..	4·85	123	+ 6	17	..	..	Suva, Fiji.
..	..	71	6·7	1·21	31	− 11	7	..	..	Kingston, Jamaica.
75·3	..	75	4·1	7·09	180	− 69	20	..	..	Grenada, W.I.
69·7	55	73	4·0	2·65	67	− 10	11	..	..	Toronto.
66·8	..	68	4·0	3·71	94	+ 17	10	..	..	Winnipeg.
57·3	43	89	6·7	1·67	42	− 50	7	..	..	St. John, N.B.
52·5	41	76	2·7	0·15	4	− 5	3	..	..	Victoria, B.C.

* For Indian stations a rain day is a day on which 0·1 in. (2·5 mm.) or more rain has fallen.

SYDNEY.—Mean max. and mean min. temp. highest on record.
ADELAIDE.—With one exception mildest July on record.
PERTH, W. AUSTRALIA.—Abs. max. highest on record for July since 1896.
BRISBANE.—Mean temp. highest on record for July.
WELLINGTON, N.Z.—1 day with hail.
GRENADA.—Prevailing wind direction E.

										MAURITIUS :—
72·7	62	77	6·2	10·36	263	+ 66	23	8·7	67	January 1921.
73·8	64	80	6·7	5·03	128	− 85	23	7·3	58	February.
72·9	64	80	5·7	6·83	173	− 65	25	8·5	70	March.
68·5	55	75	5·4	2·67	68	− 46	13	7·7	66	April.

March.—Prevailing wind direction E ; mean speed 10·7 mi/hr.
April.—Prevailing wind direction ESE ; mean speed 6·8 mi/hr.

pressure distribution in southern Brazil was dominated by anticyclones moving from west to east. The crops, especially coffee and sugar cane, are affected by the scarcity of precipitation.

The rainfall of the month was below the average over the greater part of the British Isles, being less than half the average in the neighbourhood of London, in eastern Aberdeenshire, and in the south-east of Ireland. Only about one-third of the area of England received as much as 75 per cent. of the average and this was confined to the north-west. Locally in this district more than the average rainfall was recorded, reaching 135 per cent. at Seathwaite. In Scotland more than the average fell generally in the west, north-west, and south-west, and in Ireland most of the northern half had more than the average. More than 25 mm. (1 in.) during the month was recorded practically everywhere in the British Isles, the area in England with between 25 and 75 mm. (1 to 3 in.) being unusually large. More than 500 mm. (20 in.) fell in the English Lake District. In Scotland a considerable part of the Western Highlands received more than 250 mm. (10 in.) while as much as 1,031 mm. (40·60 in.) fell at Loan, a very rare occurrence even in this extraordinarily rainy region. In Ireland falls less than 25 mm. (1 in.) were confined to the south-east, while in the north-west more than 100 mm. (4 in.) fell generally. More than 250 mm. (10 in.) fell in the mountains of Connemara and Kerry.

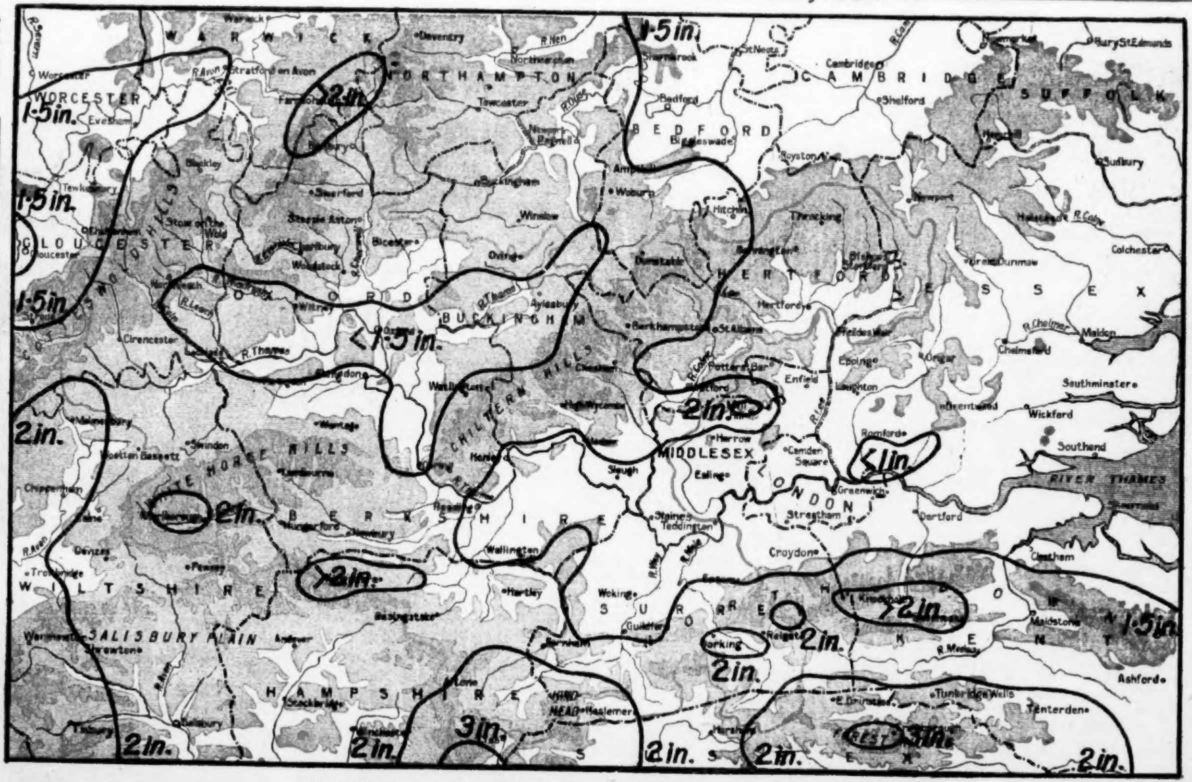
At Falstone Rectory in Northumberland 92 mm. (3·61 in.) fell on the 26th, and 61 mm. (2·39 in.) on the 30th, making 195 mm. (7·67 in.) in 5 consecutive days.

The general rainfall for December, expressed as a percentage of the average, was:—England and Wales, 83; Scotland, 133; Ireland, 80; British Isles, 101.

For the 11 months February to December a considerable area in the south-east of England has received less than half its average rainfall for the period. The areas with this deficiency are situated respectively in a broad band along the coast from Hampshire to Kent and in Herefordshire. Less than 60 per cent. of the average fell during these 11 months over about half the area of England to the south of a line roughly from Swansea to Boston. In the Western Highlands of Scotland the rainfall in this period was generally just above the average. In Ireland the fall has been nearly everywhere between 75 and 95 per cent. of the average.

In London, Camden Square, the mean temperature for December was 44·4° F. or 4·3° F. above the average. Duration of rainfall, 24·3 hours; evaporation, ·28 inch.

THAMES VALLEY RAINFALL. —— DECEMBER, 1921.



Watershed of River Thames above Teddington, and River Lea above Feilde's Weir.

Isohyetals.

ALTITUDE SCALE: Below 250 feet | 250 to 500 feet | 500 to 1000 feet | Above 1000 feet

SCALE OF MILES: 0 5 10 15 20

H.M. Stationery Office Press Kingsway W.C.2

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